South Dakota
SURVEY REPORT

Compilation of Pronghorn Survey Methods and Results Reports

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INTRODUCTION

Population objectives are established across pronghorn (*Antilocapra americana*) harvest management units in South Dakota (Figure 1). The South Dakota Game, Fish and Parks (GFP) Commission sets biennial pronghorn hunting license allocation and season structure regulations, and these are used as the primary management option to meet population objective goals. Estimates of the pronghorn population and harvest effects are used to inform management recommendations across management units. Age- and sex-ratio data from pre-hunting season herd composition surveys provide 2 valuable sources of information about the pronghorn population. Specifically, age-ratios, fawn:100 adult females, are used to estimate annual recruitment rates, and sex-ratios, adult male:100 adult females, are used to estimate adult female and adult male cohorts from spring abundance surveys conducted every 2 years across the pronghorn range in South Dakota. Both sources of data are integral for projecting future pronghorn populations. In addition, annual monitoring of recruitment can alert managers when fawn survival substantially deviates from normal ranges (e.g., severe drought resulting in poor survival from birth to hunting season) and provide a means for proactive management to mitigate erratic changes in pronghorn abundance.

METHODS

Pre-hunting season herd composition surveys are completed by driving roads in areas of known pronghorn concentrations in September. Surveys are concentrated in locations across South Dakota according to where pronghorn are distributed and can be observed. Although there is no statistical survey design, survey efforts are designed to provide the most efficient data collection while still representing the South Dakota pronghorn population. A minimum sample size goal of 200 groups per data analysis unit (DAU) ensures adequate sample sizes are obtained. In addition to spring aerial observation surveys, GFP staff familiarity of pronghorn distribution before the hunting season helps facilitate representation of the survey. All pronghorn groups that are observed in their entirety are classified to numbers of fawns, adult females, and adult males. Location and date of observations are also recorded to reduce double-counting occurrences.

Sex ratios are calculated as adult males:100 adult females. Age ratios are calculated as fawns:100 adult females. Detection probability is assumed to be similar for all cohorts during September. Consistency in the monitoring design and recurrent, 2-year abundance surveys

allows models to be calibrated to account for potential bias in estimates. Furthermore, ratio data are analyzed at the DAU level to reduce sampling variance.

Model Structure

The multinomial distribution is used to model the proportion (π) of observations within each of the 3 cohorts (*k*); fawns, adult females, and adult males.

$$\pi_k = \left[\frac{exp(\eta_k)}{\sum_{k=1}^{K} exp(\eta_k)}\right]$$

Age- and sex- ratios, are then calculated from the proportions. For example, the fawns:100 adult female ratio can be calculated by dividing the proportion of fawns by the proportion of adult females and multiplying by 100. The sampling unit is treated as each individual pronghorn observed. Markov Chain Monte Carlo iterations are used to fit models in Program R and estimate age- and sex- ratios with associated standard errors and 95% credible intervals (Plummer 2003, R Development Core Team 2016, Su and Yajima 2015).

RESULTS

By DAU in 2021, male to 100 female ratios ranged 29 to 42 and fawn to 100 female ratios ranged 37 to 53. Historic herd composition data and estimates are included in appendix 1.

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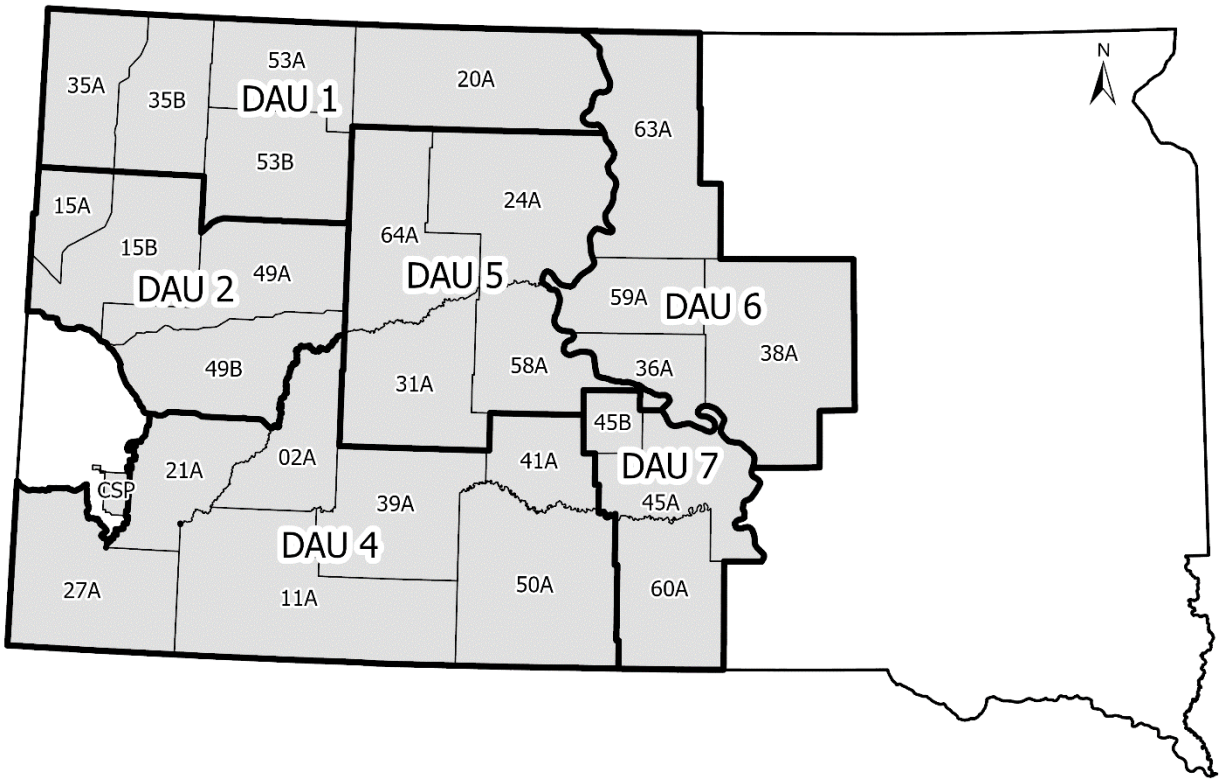

Figure 1. Pronghorn management units (thin black lines) spanning western South Dakota. Pronghorn data analysis units (DAUs) are indicated with thick black lines.

APPENDIX 1

Pronghorn fall herd composition observation survey data and results by Data Analysis Unit, 2012-2021.

DAU	Year	Ad. Males	Ad. Does	Fawns	Males:100 Does	Fawns:100 Does
1	2012	122	310	175	39.4	56.5
2	2012	568	1214	1010	46.8	83.2
4	2012	396	1312	808	30.2	61.6
5	2012	155	520	236	29.8	45.4
6	2012	38	77	48	49.4	62.3
7	2012	33	102	35	32.4	34.3
1	2013	160	710	658	22.5	92.7
2	2013	584	1591	1083	36.7	68.1
4	2013	432	1402	668	30.8	47.6
5	2013	232	459	192	50.5	41.8
6	2013	61	126	48	48.4	38.1
7	2013	14	56	39	25	69.6
1	2014	347	1089	616	31.9	56.6
2	2014	229	887	601	25.8	67.8
4	2014	283	1023	658	27.7	64.3
5	2014	99	306	118	32.4	38.6
6	2014	52	125	57	41.6	45.6
7	2014	31	91	30	34.1	33
1	2015	198	536	397	36.9	74.1
2	2015	344	988	786	34.8	79.6
4	2015	266	801	440	33.2	54.9
5	2015	110	376	187	29.3	49.7
6	2015	49	179	98	27.4	54.7
7	2015	38	133	45	28.6	33.8
1	2016	275	893	620	30.8	69.4
2	2016	342	1074	880	31.8	81.9
4	2016	275	960	473	28.6	49.3
5	2016	141	296	186	47.6	62.8
6	2016	53	184	130	28.8	70.7
7	2016	46	127	59	36.2	46.5
1	2017	386	991	732	39	73.9
2	2017	395	970	698	40.7	72
4	2017	310	1062	550	29.2	51.8
5	2017	185	552	281	33.5	50.9
6	2017	118	294	146	40.1	49.7
7	2017	62	150	64	41.3	42.7
1	2018	417	1044	701	39.9	67.1
2	2018	310	681	416	45.5	61.1
4	2018	300	897	448	33.4	49.9
5	2018	272	589	337	46.2	57.2
6	2018	179	337	156	53.1	46.3
7	2018	93	161	73	57.8	45.3
1	2019	452	1107	598	40.8	54
2	2019	301	709	513	42.5	72.4
4	2019	271	710	431	38.2	60.7
5	2019	237	687	332	34.5	48.3
6	2019	176	315	162	55.9	51.4

DAU	Year	Ad. Males	Ad. Does	Fawns	Males:100 Does	Fawns:100 Does
7	2019	75	110	49	68.2	44.5
1	2020	391	837	482	46.7	57.6
2	2020	336	819	549	41	67
4	2020	278	868	467	32	53.8
5	2020	198	588	315	33.7	53.6
6	2020	119	263	134	45.2	51
7	2020	85	177	101	48	57.1
1	2021	311	803	375	38.7	46.7
2	2021	203	486	256	41.8	52.7
4	2021	180	623	332	28.9	53.3
5	2021	154	420	188	36.7	44.8
6	2021	85	206	76	41.3	36.9
7	2021	46	112	52	41.1	46.4

ESTIMATING PRONGHORN SURVIVAL

INTRODUCTION

Population management objectives are established across pronghorn (*Antilocapra americana*) harvest management units in South Dakota (Figure 1). The South Dakota Game, Fish and Parks (GFP) Commission sets biennial pronghorn hunting license allocation and season structure regulations, and these are used as the primary management option to meet population objective goals. Annual survival and cause-specific mortality estimates provide valuable sources of information about the pronghorn population. Specifically, annual survival rates are used to project future pronghorn populations when aerial survey estimates are not available. In addition, intermittent monitoring of adult female or fawn survival rates can alert managers when survival substantially deviates from normal ranges (e.g., severe drought or winter resulting in significant starvation) and provide a means for proactive management to mitigate erratic changes in pronghorn abundance (GFP 2019).

METHODS

Adult females and young-of-the-year pronghorn are captured via helicopter net gunning. Captured animals were traditionally monitored with very high frequency (VHF) radiocollars, and since 2020, all pronghorn were fitted with global positioning systems (GPS) collars to provide additional data on movements and habitat use.

Monitoring alive or dead status for pronghorn occurs within 12-16 days post-capture for all VHF collars and all mortalities (<16 days post capture) are labeled as capture-related mortalities, except for vehicle mortalities. Monitoring for all VHF collared pronghorn then occurred one time each month. GPS collared pronghorn are continuously monitored for movement and multiple locations are estimated each day. All mortalities are investigated to verify death of the animal via physical evidence. In most cases, cause-specific mortality is not identifiable except for vehicle collisions and hunter harvest. Hunter harvest is an important metric used in population modeling and collar reporting by hunters is a vital step in obtaining the most accurate data possible.

Model Structure

Survival rates are calculated from time-to-event data using a hierarchical piecewise constant hazard (Λ) model, smoothed among monthly intervals (Walsh et al. 2018). The multinomial distribution partitioned hazards to estimate cause-specific mortality rates.

The likelihood for the cause-specific mortality model was the joint probability that a subject (*i*) was alive through interval *u* – 1, died during interval *u*, and the cause of death was assigned to the k^{th} source of mortality:

$$Pr(\, t < T_i < t + \Delta, K = k | T_i > t) = \psi_{i,k,u} = exp\left(-\sum_{u=1}^{u-1} \Lambda_{i,u}\right) \times \left[1 - exp\left(\Lambda_{i,u}\right)\right] \times \pi_{i,u,k},$$

where

$$\pi_{u,k} = \left[\frac{exp(\eta_{u,k})}{\sum_{k=1}^{K} exp(\eta_{u,k})}\right],$$

and: $ln(\,\Lambda_u) = \gamma_u + \beta_{j,u} x_{i,j,u}$, where γ_u represents the baseline log cumulative hazard for the u^{th} interval, $x_{i,j,u}$ = the j^{th} covariate for the i^{th} subject during the u^{th} interval, and $\beta_{j,u}$ = is the effect of the j^{th} covariate during the u^{th} interval and is the log hazard ratio.

Log cumulative hazards and multinomial probabilities were smoothed among monthly intervals. An example of the regularization structure for the intercept of the log cumulative hazard, $\gamma_{0,u}$, was: $\gamma_{0,u} \sim N\left(\gamma_0, \sigma^2\right)$ where $\gamma_0 \sim N\left(0{,}100^2\right)$ and $\sigma \sim Uniform(0{,}10)$.

Markov Chain Monte Carlo iterations are used to fit models in Program R and estimate cause-specific mortality rates with associated standard errors and 95% credible intervals (Plummer 2003, R Development Core Team 2016, Su and Yajima 2015).

RESULTS

In 2021, 247 pronghorn were continuously monitored in data analysis units (DAUs) 1 and 6 using GPS collars to assess annual survival rates. Annual survival estimates are provided in appendix 1 and appendix 2.

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Plummer, M. (2003) JAGS: A program for analysis of Bayesian graphical models using Gibbs sampling. In *Proceedings of the 3rd International Workshop on Distributed Statistical Computing* (eds K. Hornik, F. Leisch and A. Zeileis). Vienna, Austria. See www.ci.tuwien.ac.at/Conferences/DSC-2003/Proceedings/Plummer.pdf.

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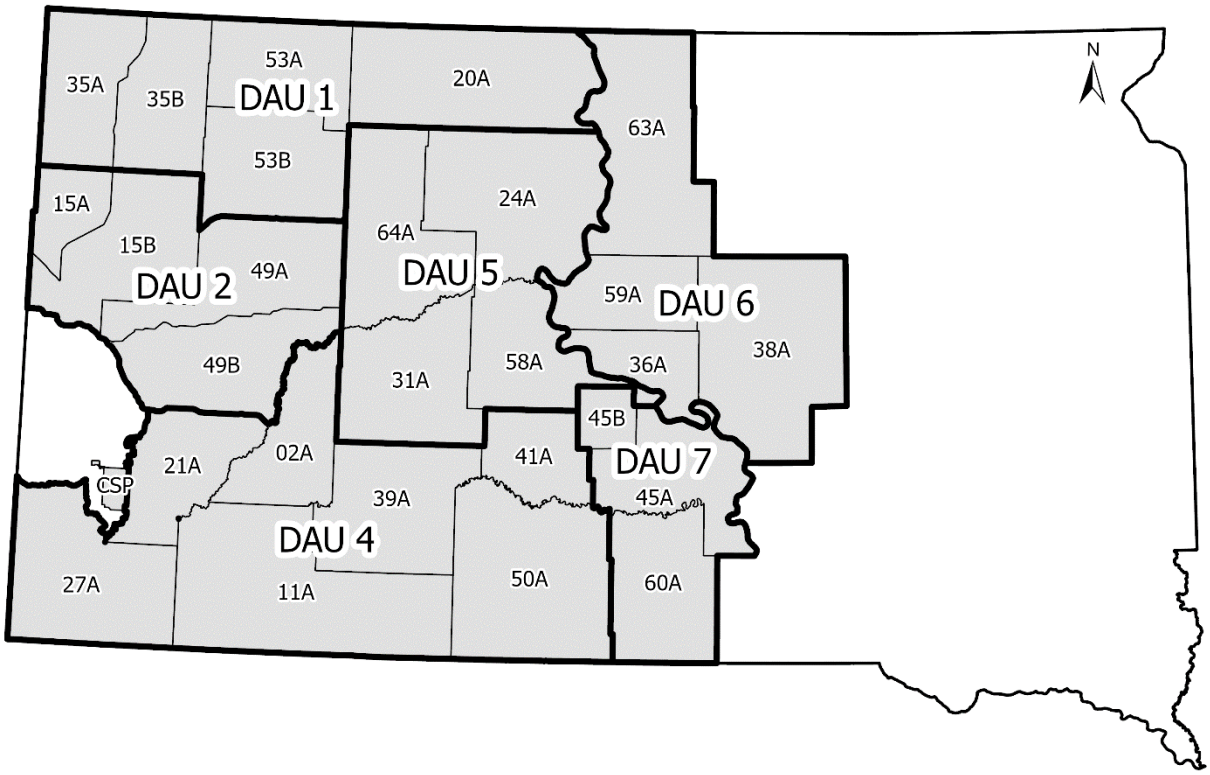

Figure 1. Pronghorn management units (thin black lines) spanning western South Dakota. Pronghorn data analysis units are indicated with thick black lines.

APPENDIX 1

Annual survival rates by data analysis unit (DAU) using very high frequency (VHF) radiocollars, 2002-2016 (GFP 2019).

Year	DAU	Sex	Age	Annual Survival	# Monitored
2002	1	Female	Adult	89%	45
2003	1	Female	Adult	87%	52
2004	1	Female	Adult	83%	41
2003	4	Female	Adult	89%	37
2004	4	Female	Adult	82%	36
2015	2	Female	Adult	85%	48
2016	2	Female	Adult	89%	61
2015	2	Female	Juvenile	76%	10
2016	2	Female	Juvenile	81%	24

APPENDIX 2

Annual survival rates by data analysis unit (DAU) using global positioning systems (GPS) and very high frequency (VHF) radiocollars, 2017-2021.

Year	Dates	DAU	Sex	Age	Annual Survival	SD	# Monitored
2020	1.2020_8.2020	1	Female	Adult	72%	0.077	65
2021	9.2020_8.2021	1	Female	Adult	79%	0.051	141
2017	9.2016_8.2017	4	Female	Adult	89%	0.035	104
2018	9.2017_8.2018	4	Female	Adult	74%	0.059	118
2019	9.2018_8.2019	4	Female	Adult	69%	0.064	117
2020	9.2019_8.2020	4	Female	Adult	79%	0.058	88
2020	1.2020_8.2020	6	Female	Adult	70%	0.086	57
2021	9.2020_8.2021	6	Female	Adult	83%	0.047	106
2020	1.2020_8.2020	1	Both	Juvenile	71%	0.074	76
2020	1.2020_8.2020	6	Both	Juvenile	83%	0.051	80

ESTIMATING PRONGHORN HARVEST

INTRODUCTION

Population management objectives are established across pronghorn (*Antilocapra americana*) harvest management units in South Dakota (Figure 1). The South Dakota Game, Fish and Parks (GFP) Commission sets biennial pronghorn hunting license allocation and season structure regulations, and these are used as the primary management option to meet population objective goals. Estimates of the pronghorn population and harvest effects are used to inform management recommendations across management units. Additionally, the population projection model used to predict future population growth is based on expected changes to adult and juvenile cohorts for both sexes from harvest removal across various hunting seasons (GFP 2019).

METHODS

Harvest of adult male, adult female, male fawns, and female fawns are estimated annually by surveying all pronghorn hunters and estimating harvest based on reporting rates (GFP 2021). Harvest is estimated for each license type (41 = any antelope; 42 = any buck antelope; 43 = doe/fawn antelope; 48 = any antelope and any doe/fawn; 49 = any 2 doe/fawn antelope) and hunting unit among 6 different hunting seasons including: 1) Firearms antelope; 2) Archery antelope; 3) Custer State Park antelope; 4) Special antelope; 5) Landowner antelope; and 6) Mentored antelope.

Surveys were administered using email internet surveys with follow-up reminders to non-respondents to obtain the number of hunting recreation days, gender and age (adult/fawn) of pronghorn harvested if successful, and hunter satisfaction. Total harvest was estimated by dividing the reported harvest by the proportions of hunters that responded for each unit and respondents were assumed to be representative of the population of hunters in each unit.

RESULTS

In 2021, 9,073 pronghorn licenses were sold (5,207 firearm and landowner, 3,019 archery, 847 mentor), and 3,043 males and 1,651 females were harvested based on hunter survey data. More detailed harvest data are in appendix 1.

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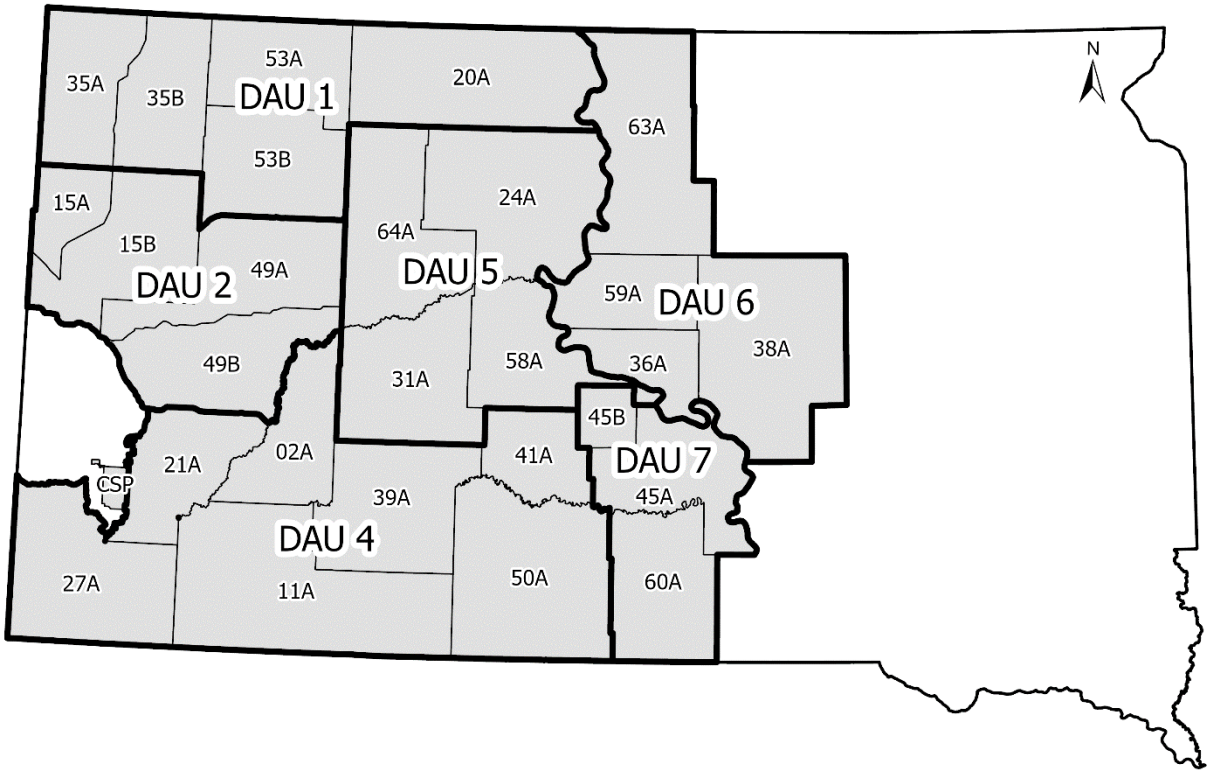

Figure 1. Pronghorn management units (thin black lines) spanning western South Dakota. Pronghorn data analysis units are indicated with thick black lines.

APPENDIX 1

Pronghorn harvest estimates, 2016-2021.

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2016	Archery	02A	NA	4	1	0	0
2016	Archery	11A	NA	1	0	0	0
2016	Archery	13A	NA	0	0	0	0
2016	Archery	14A	NA	6	0	0	0
2016	Archery	15A	NA	43	3	4	0
2016	Archery	15B	NA	50	3	1	0
2016	Archery	16A	NA	1	0	0	0
2016	Archery	20A	NA	1	0	0	0
2016	Archery	21A	NA	7	1	0	0
2016	Archery	24A	NA	4	0	1	0
2016	Archery	27A	NA	27	6	0	4
2016	Archery	31A	NA	0	0	0	0
2016	Archery	33A	NA	1	0	0	0
2016	Archery	35A	NA	163	6	1	0
2016	Archery	35B	NA	30	1	0	0
2016	Archery	36A	NA	3	1	0	0
2016	Archery	39A	NA	4	0	0	0
2016	Archery	41A	NA	1	0	0	0
2016	Archery	45A	NA	0	0	0	0
2016	Archery	45B	NA	0	0	0	0
2016	Archery	49A	NA	23	7	0	0
2016	Archery	49B	NA	10	1	1	0
2016	Archery	50A	NA	3	0	0	0
2016	Archery	53A	NA	14	0	0	0
2016	Archery	53B	NA	30	6	0	0
2016	Archery	58A	NA	1	0	0	0
2016	Archery	59A	NA	9	0	0	0
2016	Archery	60A	NA	0	0	0	0
2016	Archery	63A	NA	0	0	0	0
2016	Archery	64A	NA	16	0	0	0
2016	Archery	BH	NA	0	0	0	0
2016	Landowner	02A	NA	3	0	0	0
2016	Landowner	11A	NA	1	2	0	0
2016	Landowner	15A	NA	10	3	0	2
2016	Landowner	15B	NA	7	2	0	0
2016	Landowner	20A	NA	4	2	0	0
2016	Landowner	21A	NA	3	2	2	0
2016	Landowner	24A	NA	3	0	0	0
2016	Landowner	27A	NA	4	3	0	0
2016	Landowner	31A	NA	9	0	0	0
2016	Landowner	35A	NA	7	7	0	0
2016	Landowner	35B	NA	6	8	2	0
2016	Landowner	36A	NA	4	0	0	0
2016	Landowner	39A	NA	7	2	0	0
2016	Landowner	41A	NA	6	2	0	0
2016	Landowner	45A	NA	0	0	0	0

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2016	Landowner	45B	NA	0	0	0	0
2016	Landowner	49A	NA	23	12	4	2
2016	Landowner	49B	NA	16	18	0	0
2016	Landowner	50A	NA	1	2	0	0
2016	Landowner	53A	NA	7	5	0	3
2016	Landowner	53B	NA	7	5	2	2
2016	Landowner	58A	NA	3	0	0	0
2016	Landowner	59A	NA	3	2	0	0
2016	Landowner	60A	NA	0	0	0	0
2016	Landowner	63A	NA	0	0	0	0
2016	Landowner	64A	NA	3	2	0	0
2016	Mentored	02A	NA	0	6	3	0
2016	Mentored	11A	NA	0	0	0	0
2016	Mentored	13A	NA	0	0	0	0
2016	Mentored	14A	NA	0	0	0	0
2016	Mentored	15A	NA	0	10	0	0
2016	Mentored	15B	NA	0	20	1	3
2016	Mentored	16A	NA	0	0	0	0
2016	Mentored	20A	NA	0	3	0	0
2016	Mentored	21A	NA	0	9	0	2
2016	Mentored	24A	NA	0	0	1	0
2016	Mentored	27A	NA	0	33	6	5
2016	Mentored	31A	NA	0	1	1	0
2016	Mentored	33A	NA	0	0	0	0
2016	Mentored	35A	NA	0	16	4	0
2016	Mentored	35B	NA	0	19	1	2
2016	Mentored	36A	NA	0	6	0	0
2016	Mentored	39A	NA	0	9	0	0
2016	Mentored	41A	NA	0	1	0	0
2016	Mentored	45A	NA	0	0	0	0
2016	Mentored	45B	NA	0	0	0	0
2016	Mentored	49A	NA	0	34	0	0
2016	Mentored	49B	NA	0	11	1	0
2016	Mentored	50A	NA	0	0	0	0
2016	Mentored	53A	NA	0	3	3	0
2016	Mentored	53B	NA	0	26	4	2
2016	Mentored	58A	NA	0	7	0	0
2016	Mentored	59A	NA	0	6	0	0
2016	Mentored	60A	NA	0	0	0	0
2016	Mentored	63A	NA	0	0	0	0
2016	Mentored	64A	NA	0	7	1	0
2016	Firearms	02A	41	73	15	2	0
2016	Firearms	11A	41	32	1	0	0
2016	Firearms	15A	41	145	14	3	5
2016	Firearms	15B	41	172	20	4	3
2016	Firearms	20A	41	19	4	1	1
2016	Firearms	21A	41	66	9	2	1
2016	Firearms	24A	41	10	5	1	0

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2016	Firearms	27A	41	315	48	13	7
2016	Firearms	31A	41	57	5	0	0
2016	Firearms	35A	41	156	8	3	0
2016	Firearms	35B	41	122	10	0	0
2016	Firearms	36A	41	22	0	0	0
2016	Firearms	39A	41	21	5	1	0
2016	Firearms	41A	41	4	0	0	0
2016	Firearms	49A	41	264	42	11	0
2016	Firearms	49B	41	131	27	5	1
2016	Firearms	50A	41	6	3	0	0
2016	Firearms	53A	41	70	5	0	1
2016	Firearms	53B	41	123	8	0	0
2016	Firearms	58A	41	26	1	2	0
2016	Firearms	59A	41	13	3	0	0
2016	Firearms	64A	41	64	12	1	1
2017	Archery	02A	NA	9	0	0	0
2017	Archery	11A	NA	1	0	0	0
2017	Archery	13A	NA	0	0	0	0
2017	Archery	14A	NA	18	0	0	0
2017	Archery	15A	NA	46	3	0	0
2017	Archery	15B	NA	65	4	6	1
2017	Archery	16A	NA	0	0	0	0
2017	Archery	20A	NA	7	0	0	0
2017	Archery	21A	NA	6	0	1	0
2017	Archery	24A	NA	1	0	0	0
2017	Archery	27A	NA	24	9	1	0
2017	Archery	31A	NA	3	1	0	0
2017	Archery	33A	NA	3	0	0	0
2017	Archery	35A	NA	162	11	3	1
2017	Archery	35B	NA	41	4	3	1
2017	Archery	36A	NA	3	0	1	0
2017	Archery	39A	NA	6	1	1	0
2017	Archery	41A	NA	4	0	0	0
2017	Archery	45A	NA	0	0	0	0
2017	Archery	45B	NA	0	0	0	0
2017	Archery	49A	NA	36	3	1	0
2017	Archery	49B	NA	10	1	0	0
2017	Archery	50A	NA	0	0	0	0
2017	Archery	53A	NA	14	1	1	0
2017	Archery	53B	NA	24	4	1	1
2017	Archery	58A	NA	0	0	0	0
2017	Archery	59A	NA	16	1	0	0
2017	Archery	60A	NA	0	0	0	0
2017	Archery	63A	NA	3	0	0	0
2017	Archery	64A	NA	6	0	0	0
2017	Archery	BH	NA	0	0	0	0
2017	Landowner	02A	NA	2	0	0	0
2017	Landowner	11A	NA	2	0	0	0

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2017	Landowner	15A	NA	8	5	0	0
2017	Landowner	15B	NA	16	6	0	0
2017	Landowner	20A	NA	2	0	0	0
2017	Landowner	21A	NA	3	0	0	0
2017	Landowner	24A	NA	2	2	0	0
2017	Landowner	27A	NA	3	3	2	2
2017	Landowner	31A	NA	2	3	0	0
2017	Landowner	35A	NA	2	3	0	0
2017	Landowner	35B	NA	8	5	0	0
2017	Landowner	36A	NA	8	3	0	0
2017	Landowner	39A	NA	3	2	0	0
2017	Landowner	41A	NA	8	2	0	0
2017	Landowner	45A	NA	0	0	0	0
2017	Landowner	45B	NA	0	0	0	0
2017	Landowner	49A	NA	31	13	0	2
2017	Landowner	49B	NA	19	3	2	3
2017	Landowner	50A	NA	3	0	0	0
2017	Landowner	53A	NA	6	2	0	2
2017	Landowner	53B	NA	14	13	0	0
2017	Landowner	58A	NA	3	2	0	0
2017	Landowner	59A	NA	8	0	0	0
2017	Landowner	60A	NA	0	0	0	0
2017	Landowner	63A	NA	3	0	0	0
2017	Landowner	64A	NA	5	3	0	2
2017	Mentored	02A	NA	0	6	0	0
2017	Mentored	11A	NA	0	1	0	0
2017	Mentored	13A	NA	0	0	0	0
2017	Mentored	14A	NA	0	0	0	0
2017	Mentored	15A	NA	0	15	1	0
2017	Mentored	15B	NA	0	26	10	4
2017	Mentored	16A	NA	0	0	0	0
2017	Mentored	20A	NA	0	1	0	0
2017	Mentored	21A	NA	0	15	4	0
2017	Mentored	24A	NA	0	1	0	0
2017	Mentored	27A	NA	0	28	3	0
2017	Mentored	31A	NA	0	0	0	0
2017	Mentored	33A	NA	0	0	0	0
2017	Mentored	35A	NA	0	26	6	4
2017	Mentored	35B	NA	0	17	3	3
2017	Mentored	36A	NA	0	4	0	0
2017	Mentored	39A	NA	0	6	0	0
2017	Mentored	41A	NA	0	1	0	0
2017	Mentored	45A	NA	0	0	0	0
2017	Mentored	45B	NA	0	0	0	0
2017	Mentored	49A	NA	0	19	1	3
2017	Mentored	49B	NA	0	10	3	4
2017	Mentored	50A	NA	0	0	0	0
2017	Mentored	53A	NA	0	15	0	0

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2017	Mentored	53B	NA	0	25	1	4
2017	Mentored	58A	NA	0	12	0	1
2017	Mentored	59A	NA	0	4	1	0
2017	Mentored	60A	NA	0	0	0	0
2017	Mentored	63A	NA	0	6	0	0
2017	Mentored	64A	NA	0	6	0	1
2017	Firearms	02A	41	72	17	3	0
2017	Firearms	11A	41	31	6	0	0
2017	Firearms	15A	48	146	116	32	23
2017	Firearms	15B	41	219	15	0	0
2017	Firearms	15B	43	0	141	15	20
2017	Firearms	20A	41	26	4	0	0
2017	Firearms	21A	41	61	11	1	0
2017	Firearms	24A	41	19	2	1	0
2017	Firearms	27A	41	304	62	14	7
2017	Firearms	31A	41	40	11	0	0
2017	Firearms	35A	41	233	9	3	2
2017	Firearms	35B	41	198	17	8	3
2017	Firearms	36A	41	30	2	0	0
2017	Firearms	39A	41	29	5	3	0
2017	Firearms	41A	41	20	1	1	0
2017	Firearms	49A	41	300	37	12	5
2017	Firearms	49A	43	4	116	26	13
2017	Firearms	49B	41	215	17	4	4
2017	Firearms	49B	43	0	80	7	15
2017	Firearms	50A	41	17	0	0	0
2017	Firearms	53A	41	94	13	3	1
2017	Firearms	53B	41	192	13	3	0
2017	Firearms	53B	43	0	180	19	25
2017	Firearms	58A	41	19	8	1	0
2017	Firearms	59A	41	14	2	0	2
2017	Firearms	63A	41	11	0	0	0
2017	Firearms	64A	41	80	9	2	0
2018	Archery	02A	NA	7	0	0	0
2018	Archery	11A	NA	1	0	0	0
2018	Archery	13A	NA	0	0	0	0
2018	Archery	14A	NA	0	0	0	0
2018	Archery	15A	NA	44	4	0	0
2018	Archery	15B	NA	51	4	0	0
2018	Archery	16A	NA	0	0	2	0
2018	Archery	20A	NA	4	0	0	0
2018	Archery	21A	NA	7	1	0	1
2018	Archery	24A	NA	3	0	0	0
2018	Archery	27A	NA	35	7	0	1
2018	Archery	31A	NA	3	0	0	0
2018	Archery	33A	NA	1	0	0	0
2018	Archery	35A	NA	196	16	3	4
2018	Archery	35B	NA	39	0	3	1

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2018	Archery	36A	NA	1	0	0	0
2018	Archery	39A	NA	4	1	0	0
2018	Archery	41A	NA	4	0	0	0
2018	Archery	45A	NA	0	0	0	0
2018	Archery	45B	NA	0	0	0	0
2018	Archery	49A	NA	29	3	0	0
2018	Archery	49B	NA	1	0	2	0
2018	Archery	50A	NA	1	1	0	0
2018	Archery	53A	NA	22	1	0	0
2018	Archery	53B	NA	38	4	0	1
2018	Archery	58A	NA	4	1	0	0
2018	Archery	59A	NA	9	0	0	0
2018	Archery	60A	NA	0	0	0	0
2018	Archery	63A	NA	1	0	0	0
2018	Archery	64A	NA	9	0	0	0
2018	Archery	BH	NA	0	0	0	0
2018	Landowner	02A	NA	3	2	0	0
2018	Landowner	11A	NA	5	2	0	0
2018	Landowner	15A	NA	7	2	0	0
2018	Landowner	15B	NA	19	11	6	2
2018	Landowner	20A	NA	7	0	0	0
2018	Landowner	21A	NA	15	5	0	2
2018	Landowner	24A	NA	7	0	0	0
2018	Landowner	27A	NA	5	0	0	0
2018	Landowner	31A	NA	7	0	0	0
2018	Landowner	35A	NA	9	5	0	0
2018	Landowner	35B	NA	12	2	0	0
2018	Landowner	36A	NA	5	0	0	0
2018	Landowner	39A	NA	10	4	0	0
2018	Landowner	41A	NA	5	2	0	0
2018	Landowner	45A	NA	0	0	0	0
2018	Landowner	45B	NA	0	0	0	0
2018	Landowner	49A	NA	38	5	0	0
2018	Landowner	49B	NA	14	13	0	2
2018	Landowner	50A	NA	2	0	0	0
2018	Landowner	53A	NA	15	7	0	0
2018	Landowner	53B	NA	17	14	0	0
2018	Landowner	58A	NA	3	0	0	0
2018	Landowner	59A	NA	10	0	0	0
2018	Landowner	60A	NA	0	0	0	0
2018	Landowner	63A	NA	2	0	0	0
2018	Landowner	64A	NA	9	4	0	0
2018	Mentored	02A	NA	0	17	1	4
2018	Mentored	11A	NA	0	6	0	1
2018	Mentored	13A	NA	0	0	0	0
2018	Mentored	14A	NA	0	0	0	0
2018	Mentored	15A	NA	0	12	0	3
2018	Mentored	15B	NA	0	17	6	4

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2018	Mentored	16A	NA	0	0	0	0
2018	Mentored	20A	NA	0	4	0	0
2018	Mentored	21A	NA	0	17	1	0
2018	Mentored	24A	NA	0	1	0	1
2018	Mentored	27A	NA	0	22	7	6
2018	Mentored	31A	NA	0	1	0	0
2018	Mentored	33A	NA	0	0	0	0
2018	Mentored	35A	NA	0	35	10	4
2018	Mentored	35B	NA	0	25	1	4
2018	Mentored	36A	NA	0	4	1	0
2018	Mentored	39A	NA	0	1	1	0
2018	Mentored	41A	NA	0	1	0	1
2018	Mentored	45A	NA	0	0	0	0
2018	Mentored	45B	NA	0	0	0	0
2018	Mentored	49A	NA	0	26	1	4
2018	Mentored	49B	NA	0	25	0	1
2018	Mentored	50A	NA	0	1	0	0
2018	Mentored	53A	NA	0	20	4	0
2018	Mentored	53B	NA	0	34	3	6
2018	Mentored	58A	NA	0	6	0	0
2018	Mentored	59A	NA	0	6	0	0
2018	Mentored	60A	NA	0	0	0	0
2018	Mentored	63A	NA	0	6	0	1
2018	Mentored	64A	NA	0	4	1	0
2018	Firearms	02A	41	83	14	8	1
2018	Firearms	11A	41	33	4	1	0
2018	Firearms	15A	48	152	81	36	16
2018	Firearms	15B	41	185	22	7	0
2018	Firearms	15B	43	3	145	24	15
2018	Firearms	20A	41	39	1	0	0
2018	Firearms	21A	41	69	9	1	0
2018	Firearms	24A	41	24	1	0	0
2018	Firearms	27A	41	316	47	14	5
2018	Firearms	31A	41	55	14	0	0
2018	Firearms	35A	41	230	9	3	5
2018	Firearms	35B	41	224	15	7	0
2018	Firearms	36A	41	34	1	0	0
2018	Firearms	39A	41	38	0	0	0
2018	Firearms	41A	41	19	1	0	0
2018	Firearms	49A	41	324	23	6	3
2018	Firearms	49A	43	6	108	12	24
2018	Firearms	49B	41	175	11	9	2
2018	Firearms	49B	43	0	100	0	4
2018	Firearms	50A	41	13	3	0	0
2018	Firearms	53A	41	103	8	0	0
2018	Firearms	53B	41	187	5	0	0
2018	Firearms	53B	43	0	192	12	12
2018	Firearms	58A	41	21	1	0	0

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2018	Firearms	59A	41	26	0	0	0
2018	Firearms	63A	41	11	0	0	0
2018	Firearms	64A	41	104	13	0	0
2019	Archery	02A	NA	12	1	0	0
2019	Archery	11A	NA	0	0	0	0
2019	Archery	15A	NA	58	15	2	1
2019	Archery	15B	NA	53	6	5	0
2019	Archery	20A	NA	3	0	0	0
2019	Archery	21A	NA	10	0	0	0
2019	Archery	24A	NA	0	0	0	0
2019	Archery	27A	NA	24	1	0	0
2019	Archery	31A	NA	1	3	0	0
2019	Archery	35A	NA	176	7	3	1
2019	Archery	35B	NA	40	12	3	1
2019	Archery	36A	NA	6	0	0	0
2019	Archery	38A	NA	6	1	0	0
2019	Archery	39A	NA	9	0	0	0
2019	Archery	41A	NA	6	0	0	0
2019	Archery	45A	NA	0	0	0	0
2019	Archery	45B	NA	0	0	0	0
2019	Archery	49A	NA	30	6	3	0
2019	Archery	49B	NA	13	1	0	0
2019	Archery	50A	NA	0	1	0	0
2019	Archery	53A	NA	13	1	3	0
2019	Archery	53B	NA	27	1	0	1
2019	Archery	58A	NA	6	1	2	0
2019	Archery	59A	NA	7	4	0	0
2019	Archery	60A	NA	0	0	0	0
2019	Archery	63A	NA	7	1	0	0
2019	Archery	64A	NA	6	0	0	0
2019	Archery	BH	NA	0	0	0	0
2019	Landowner	02A	NA	5	5	0	0
2019	Landowner	11A	NA	2	2	0	0
2019	Landowner	15A	NA	8	5	2	0
2019	Landowner	15B	NA	15	7	0	0
2019	Landowner	20A	NA	3	2	0	0
2019	Landowner	21A	NA	3	5	2	2
2019	Landowner	24A	NA	2	0	0	0
2019	Landowner	27A	NA	5	2	0	0
2019	Landowner	31A	NA	12	3	0	0
2019	Landowner	33A	NA	7	3	0	0
2019	Landowner	35A	NA	10	0	0	0
2019	Landowner	35B	NA	8	3	0	0
2019	Landowner	36A	NA	7	0	0	0
2019	Landowner	39A	NA	19	7	0	0
2019	Landowner	41A	NA	8	2	0	0
2019	Landowner	49A	NA	12	7	0	0
2019	Landowner	49B	NA	17	12	0	0

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2019	Landowner	50A	NA	0	0	2	0
2019	Landowner	53A	NA	14	2	0	0
2019	Landowner	53B	NA	17	12	2	2
2019	Landowner	58A	NA	3	3	0	0
2019	Landowner	59A	NA	5	0	0	0
2019	Landowner	63A	NA	3	2	3	0
2019	Landowner	64A	NA	12	3	0	0
2019	Mentored	02A	NA	0	18	2	6
2019	Mentored	11A	NA	0	7	0	1
2019	Mentored	15A	NA	0	22	6	4
2019	Mentored	20A	NA	0	18	6	4
2019	Mentored	21A	NA	0	1	0	1
2019	Mentored	24A	NA	0	13	2	0
2019	Mentored	27A	NA	0	4	3	0
2019	Mentored	27A	NA	0	27	8	7
2019	Mentored	31A	NA	0	4	2	1
2019	Mentored	36A	NA	0	39	12	9
2019	Mentored	38A	NA	0	22	0	4
2019	Mentored	38A	NA	0	6	0	0
2019	Mentored	39A	NA	0	6	0	0
2019	Mentored	41A	NA	0	7	0	0
2019	Mentored	45A	NA	0	1	0	0
2019	Mentored	49A	NA	0	0	0	0
2019	Mentored	49B	NA	0	18	2	4
2019	Mentored	50A	NA	0	0	0	0
2019	Mentored	53A	NA	0	18	2	3
2019	Mentored	58A	NA	0	1	0	0
2019	Mentored	59A	NA	0	6	2	0
2019	Mentored	60A	NA	0	21	6	3
2019	Mentored	63A	NA	0	3	2	0
2019	Mentored	64A	NA	0	9	3	0
2019	Mentored	65A	NA	0	0	0	0
2019	Mentored	67A	NA	0	3	0	0
2019	Mentored	67A	NA	0	4	2	3
2019	Firearms	02A	41	60	10	1	0
2019	Firearms	11A	41	21	1	1	0
2019	Firearms	15A	41	129	21	3	0
2019	Firearms	15A	43	0	49	9	7
2019	Firearms	15B	41	174	19	7	2
2019	Firearms	15B	43	0	53	12	7
2019	Firearms	20A	41	49	4	0	0
2019	Firearms	21A	41	58	4	1	0
2019	Firearms	24A	41	27	4	1	0
2019	Firearms	27A	41	335	58	9	2
2019	Firearms	31A	41	54	15	3	0
2019	Firearms	35A	48	215	119	14	10
2019	Firearms	35A	49	0	265	25	51
2019	Firearms	35B	41	203	9	0	4

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2019	Firearms	35B	43	0	100	9	11
2019	Firearms	36A	41	20	0	0	0
2019	Firearms	38A	41	7	1	0	0
2019	Firearms	39A	41	35	6	0	0
2019	Firearms	41A	41	28	0	1	0
2019	Firearms	49A	41	247	20	5	5
2019	Firearms	49A	43	0	42	2	10
2019	Firearms	49B	41	173	26	2	0
2019	Firearms	49B	43	0	101	6	6
2019	Firearms	50A	41	14	7	0	0
2019	Firearms	53A	41	111	2	0	0
2019	Firearms	53B	41	182	14	0	0
2019	Firearms	53B	43	0	77	8	8
2019	Firearms	58A	41	28	2	0	0
2019	Firearms	59A	41	26	0	0	0
2019	Firearms	63A	41	10	0	0	0
2019	Firearms	64A	41	94	7	0	0
2020	Archery	02A	NA	11	2	0	0
2020	Archery	11A	NA	2	2	0	0
2020	Archery	15A	NA	78	6	0	0
2020	Archery	15B	NA	59	19	0	0
2020	Archery	20A	NA	8	0	0	0
2020	Archery	21A	NA	11	0	2	0
2020	Archery	24A	NA	6	0	0	0
2020	Archery	27A	NA	34	15	2	0
2020	Archery	31A	NA	4	0	0	0
2020	Archery	35A	NA	219	15	2	6
2020	Archery	35B	NA	65	11	2	4
2020	Archery	36A	NA	6	0	0	0
2020	Archery	38A	NA	13	0	0	0
2020	Archery	39A	NA	6	2	2	0
2020	Archery	41A	NA	10	0	0	0
2020	Archery	45A	NA	0	0	0	0
2020	Archery	45B	NA	0	2	0	0
2020	Archery	49A	NA	30	2	0	0
2020	Archery	49B	NA	23	0	0	0
2020	Archery	50A	NA	0	2	0	0
2020	Archery	53A	NA	38	2	0	0
2020	Archery	53B	NA	59	2	0	0
2020	Archery	58A	NA	4	0	2	0
2020	Archery	59A	NA	13	2	0	0
2020	Archery	60A	NA	0	0	0	0
2020	Archery	63A	NA	0	0	0	0
2020	Archery	64A	NA	8	0	0	0
2020	Archery	BH	NA	2	0	0	0
2020	Landowner	02A	NA	8	5	0	0
2020	Landowner	11A	NA	3	0	0	0
2020	Landowner	15A	NA	10	2	2	0

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2020	Landowner	15B	NA	13	15	4	2
2020	Landowner	20A	NA	3	0	0	0
2020	Landowner	21A	NA	3	0	0	0
2020	Landowner	24A	NA	8	5	2	0
2020	Landowner	27A	NA	0	0	0	0
2020	Landowner	31A	NA	5	7	0	0
2020	Landowner	35A	NA	13	0	2	0
2020	Landowner	35B	NA	8	5	0	0
2020	Landowner	36A	NA	0	2	0	0
2020	Landowner	38A	NA	5	0	0	0
2020	Landowner	39A	NA	8	0	0	0
2020	Landowner	41A	NA	0	0	0	0
2020	Landowner	49A	NA	18	5	0	4
2020	Landowner	49B	NA	8	10	2	0
2020	Landowner	50A	NA	3	0	0	0
2020	Landowner	53A	NA	18	10	0	0
2020	Landowner	53B	NA	8	5	0	0
2020	Landowner	58A	NA	5	5	0	0
2020	Landowner	59A	NA	0	0	0	0
2020	Landowner	63A	NA	0	0	0	0
2020	Landowner	64A	NA	5	2	0	0
2020	Mentored	02A	NA	0	21	4	6
2020	Mentored	11A	NA	0	8	0	0
2020	Mentored	15A	NA	0	23	6	2
2020	Mentored	15B	NA	0	2	4	4
2020	Mentored	20A	NA	0	8	0	2
2020	Mentored	21A	NA	0	6	0	2
2020	Mentored	24A	NA	0	2	2	0
2020	Mentored	27A	NA	0	29	0	4
2020	Mentored	31A	NA	0	11	0	0
2020	Mentored	35A	NA	0	42	6	6
2020	Mentored	35B	NA	0	34	4	2
2020	Mentored	36A	NA	0	4	0	0
2020	Mentored	38A	NA	0	4	0	0
2020	Mentored	39A	NA	0	15	2	4
2020	Mentored	41A	NA	0	2	0	0
2020	Mentored	45A	NA	0	0	0	0
2020	Mentored	45B	NA	0	0	0	0
2020	Mentored	49A	NA	0	21	0	2
2020	Mentored	49B	NA	0	8	0	4
2020	Mentored	50A	NA	0	2	0	2
2020	Mentored	53A	NA	0	23	2	4
2020	Mentored	53B	NA	0	25	8	4
2020	Mentored	58A	NA	0	10	0	0
2020	Mentored	59A	NA	0	0	6	0
2020	Mentored	60A	NA	0	0	0	0
2020	Mentored	63A	NA	0	0	0	0
2020	Mentored	64A	NA	0	8	0	0

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2020	Firearms	02A	41	51	8	3	4
2020	Firearms	11A	41	35	2	2	0
2020	Firearms	15A	41	101	27	11	2
2020	Firearms	15A	43	0	42	7	7
2020	Firearms	15B	41	150	21	0	4
2020	Firearms	15B	43	0	60	4	4
2020	Firearms	20A	41	41	7	0	0
2020	Firearms	21A	41	58	8	0	0
2020	Firearms	24A	41	25	3	3	3
2020	Firearms	27A	41	271	48	12	5
2020	Firearms	31A	41	40	16	0	0
2020	Firearms	35A	48	214	113	9	12
2020	Firearms	35A	49	0	271	21	42
2020	Firearms	35B	41	198	26	7	5
2020	Firearms	35B	43	0	98	7	7
2020	Firearms	36A	41	14	3	0	0
2020	Firearms	38A	41	7	0	0	0
2020	Firearms	39A	41	38	1	1	0
2020	Firearms	41A	41	25	1	0	0
2020	Firearms	49A	41	218	32	2	0
2020	Firearms	49A	43	0	45	3	3
2020	Firearms	49B	41	177	31	0	0
2020	Firearms	49B	43	0	83	13	7
2020	Firearms	50A	41	19	3	0	0
2020	Firearms	53A	41	113	10	0	0
2020	Firearms	53B	41	168	24	5	2
2020	Firearms	53B	43	0	79	18	6
2020	Firearms	58A	41	27	0	0	0
2020	Firearms	59A	41	21	0	0	2
2020	Firearms	63A	41	8	4	1	0
2020	Firearms	64A	41	106	9	0	0
2021	Archery	02A	NA	20	4	2	0
2021	Archery	11A	NA	0	2	0	0
2021	Archery	15A	NA	55	11	2	2
2021	Archery	15B	NA	40	7	2	0
2021	Archery	20A	NA	11	0	0	0
2021	Archery	21A	NA	2	2	0	0
2021	Archery	24A	NA	4	0	2	0
2021	Archery	27A	NA	29	13	0	2
2021	Archery	31A	NA	7	0	0	0
2021	Archery	35A	NA	203	27	4	0
2021	Archery	35B	NA	82	7	0	0
2021	Archery	36A	NA	7	0	0	0
2021	Archery	38A	NA	5	2	0	0
2021	Archery	39A	NA	18	4	0	0
2021	Archery	41A	NA	7	2	0	0
2021	Archery	45A	NA	0	0	0	0
2021	Archery	45B	NA	0	0	0	0

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2021	Archery	49A	NA	29	2	0	0
2021	Archery	49B	NA	9	2	2	0
2021	Archery	50A	NA	9	0	0	0
2021	Archery	53A	NA	35	4	2	0
2021	Archery	53B	NA	31	2	0	2
2021	Archery	58A	NA	2	0	0	0
2021	Archery	59A	NA	5	0	2	0
2021	Archery	60A	NA	0	0	0	0
2021	Archery	63A	NA	4	0	0	0
2021	Archery	64A	NA	9	0	0	0
2021	Archery	BH	NA	2	0	0	0
2021	Landowner	02A	NA	3	0	0	0
2021	Landowner	11A	NA	3	0	0	0
2021	Landowner	15A	NA	8	0	0	0
2021	Landowner	15B	NA	16	6	0	0
2021	Landowner	20A	NA	16	0	0	3
2021	Landowner	21A	NA	5	6	0	0
2021	Landowner	24A	NA	3	0	0	0
2021	Landowner	27A	NA	11	3	0	0
2021	Landowner	31A	NA	0	0	0	0
2021	Landowner	35A	NA	11	3	0	0
2021	Landowner	35B	NA	8	6	0	0
2021	Landowner	36A	NA	3	3	3	0
2021	Landowner	38A	NA	0	0	0	0
2021	Landowner	39A	NA	16	3	0	0
2021	Landowner	41A	NA	3	0	0	0
2021	Landowner	49A	NA	8	6	0	0
2021	Landowner	49B	NA	8	6	0	0
2021	Landowner	50A	NA	0	0	0	0
2021	Landowner	53A	NA	5	0	0	0
2021	Landowner	53B	NA	14	6	0	6
2021	Landowner	58A	NA	14	6	0	0
2021	Landowner	59A	NA	0	0	0	0
2021	Landowner	63A	NA	0	3	0	0
2021	Landowner	64A	NA	5	9	0	0
2021	Mentored	02A	NA	0	29	0	6
2021	Mentored	11A	NA	0	11	0	0
2021	Mentored	15A	NA	0	21	2	0
2021	Mentored	15B	NA	0	15	4	0
2021	Mentored	20A	NA	0	2	0	0
2021	Mentored	21A	NA	0	8	2	0
2021	Mentored	24A	NA	0	6	0	0
2021	Mentored	27A	NA	0	36	4	10
2021	Mentored	31A	NA	0	6	2	0
2021	Mentored	35A	NA	0	49	2	6
2021	Mentored	35B	NA	0	38	0	0
2021	Mentored	36A	NA	0	11	0	0
2021	Mentored	38A	NA	0	0	0	0

YEAR	SEASON	UNIT	TYPE	Adult Male	Adult Female	Male Fawn	Female Fawn
2021	Mentored	39A	NA	0	10	0	0
2021	Mentored	41A	NA	0	0	0	0
2021	Mentored	45A	NA	0	0	0	0
2021	Mentored	45B	NA	0	0	0	0
2021	Mentored	49A	NA	0	27	2	0
2021	Mentored	49B	NA	0	11	0	0
2021	Mentored	50A	NA	0	0	0	0
2021	Mentored	53A	NA	0	29	2	4
2021	Mentored	53B	NA	0	25	0	4
2021	Mentored	58A	NA	0	10	0	0
2021	Mentored	59A	NA	0	8	0	0
2021	Mentored	60A	NA	0	0	0	0
2021	Mentored	63A	NA	0	0	0	0
2021	Mentored	64A	NA	0	6	0	2
2021	Firearms	02A	41	71	8	0	0
2021	Firearms	11A	41	27	4	2	0
2021	Firearms	15A	41	94	19	6	3
2021	Firearms	15A	43	0	37	5	5
2021	Firearms	15B	41	150	20	5	2
2021	Firearms	15B	43	0	42	5	0
2021	Firearms	20A	41	41	6	0	0
2021	Firearms	21A	41	57	6	0	0
2021	Firearms	24A	41	25	2	0	0
2021	Firearms	27A	41	291	69	9	4
2021	Firearms	31A	41	44	12	0	0
2021	Firearms	35A	48	219	112	12	9
2021	Firearms	35A	49	0	254	33	43
2021	Firearms	35B	41	189	14	8	0
2021	Firearms	35B	43	0	106	14	7
2021	Firearms	36A	41	9	0	0	0
2021	Firearms	38A	41	6	0	0	0
2021	Firearms	39A	41	40	1	1	0
2021	Firearms	41A	41	26	0	0	0
2021	Firearms	49A	41	225	26	7	2
2021	Firearms	49A	43	0	53	4	4
2021	Firearms	49B	41	173	19	5	2
2021	Firearms	49B	43	0	69	16	5
2021	Firearms	50A	41	14	2	0	0
2021	Firearms	53A	41	104	9	1	0
2021	Firearms	53B	41	156	8	3	2
2021	Firearms	53B	43	0	77	8	8
2021	Firearms	58A	41	25	0	0	0
2021	Firearms	59A	41	18	4	0	0
2021	Firearms	63A	41	7	3	0	0
2021	Firearms	64A	41	84	5	0	0

ESTIMATING SPRING ADULT PROGHORN POPULATION

INTRODUCTION

Fall pronghorn (*Antilocapra americana*) population objectives are established at management units (Figure 1). Population projection models are used to annually estimate abundance from spring aerial observation survey estimates, and project future pronghorn populations and growth rates (λ) at individual management unit and data analysis units (DAUs) in South Dakota. Changes in hunting license allocation and season structure across hunting units are biennially recommended that align population objectives and growth rates (λ) with estimated abundance from aerial surveys and subsequent projection models. Aerial survey models rely on data collected from biennial aerial observation surveys (GFP 2019). In 2021, an aerial survey across the entire pronghorn range in South Dakota was not conducted and as a result, aerial survey estimates and management recommendations were delayed until 2022.

METHODS

A fixed-wing aircraft inventory of South Dakota's pronghorn population was first initiated in 1941. A review of this aerial survey method in 1951 suggested a sample of one-third of the unit (where pronghorn density was about 1/mile^2), with observers counting pronghorn up to one-quarter mile perpendicular to each side of the aircraft, usually produced population estimates with an error ≤10% (Bever 1951). A subsequent report (Robbins 1964) similarly suggested that one-third of the units should be sampled when pronghorn densities are ≥1/mile^2, and further recommended half of the unit should be flown when densities are between 0.30 to 0.99/mile^2, and the entire unit if densities are <0.3/mile^2.

Spring adult pronghorn estimates are generated biennially through aerial surveying procedures. The survey is conducted from May to mid-June during spring vegetative green-up. A fixed–wing aircraft is flown at speeds <100 mph, and altitudes between 100 to 200 feet above ground level. In units west of the Missouri River, aerial strip transects are flown 1.5 miles apart, with transect widths of 0.5 miles. Two observers, one being the pilot, record and classify all adult pronghorn (neonates are not counted) observed ≤0.25 miles of each side of the aircraft. Results from sampled areas (an approximate systematic third of each unit) are used to estimate pronghorn densities in un-sampled areas. In units east of the Missouri River, the entire area is surveyed, but transect widths are increased to 1 mile. A sightability correction factor of 86% (Kauth 2017) is applied to population counts when projecting the adult population forward.

Assuming independence among hunting units, the total statewide and DAU spring population estimates are calculated by summing total population and variance across hunting units (Thompson 2002). In Custer State Park, spring populations are not estimated using the aerial survey. Rather they are censused using ground counts where detection is expected to be 100%.

Model Structure

A ratio estimator was used to estimate the total population $(\hat{\tau})$ and variance $\left(\widehat{var}(\hat{\tau})\right)$ for each hunting unit (Caughley 1977, Thompson 2002):

$$\hat{\tau} = \frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} M_i} M;$$

$$\widehat{var}(\hat{\tau}) = \left(\frac{nM}{N\sum_{j=1}^{n} M_i}\right)\frac{N(N-n)}{n(n-1)}\sum_{j=1}^{n}\left(y_j - \frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} M_i} M_j\right)^2$$

Where:

n = total transects within unit;

y_i = total pronghorn observed per transect;

M_i = transect unit area;

M = total unit area;

N = total transects available in unit.

To account for sampling variation in hunting units and DAUs west of the Missouri River, 95% confidence intervals $\left(CI_{0.95,\hat{\tau}}\right)$, assuming a normal distribution, were estimated using:

$$CI_{0.95,\hat{\tau}} = \hat{\tau} \pm 1.96 * \sqrt{\widehat{var}(\hat{\tau})}.$$

Because detection probability is assumed 100% and all sampling units in the sampling frame are surveyed, no variance or confidence intervals were estimated for units east of the Missouri River. Models were fit to observation data in Program R (R Development Core Team 2016).

RESULTS

Aerial surveys of the pronghorn population in South Dakota were last conducted in May 2022. A total of 9,588 pronghorn were counted and the statewide spring adult estimate in 2022 was 28,264 (95% CI = 22,892 – 33,636). More detailed aerial survey data are in appendix 1.

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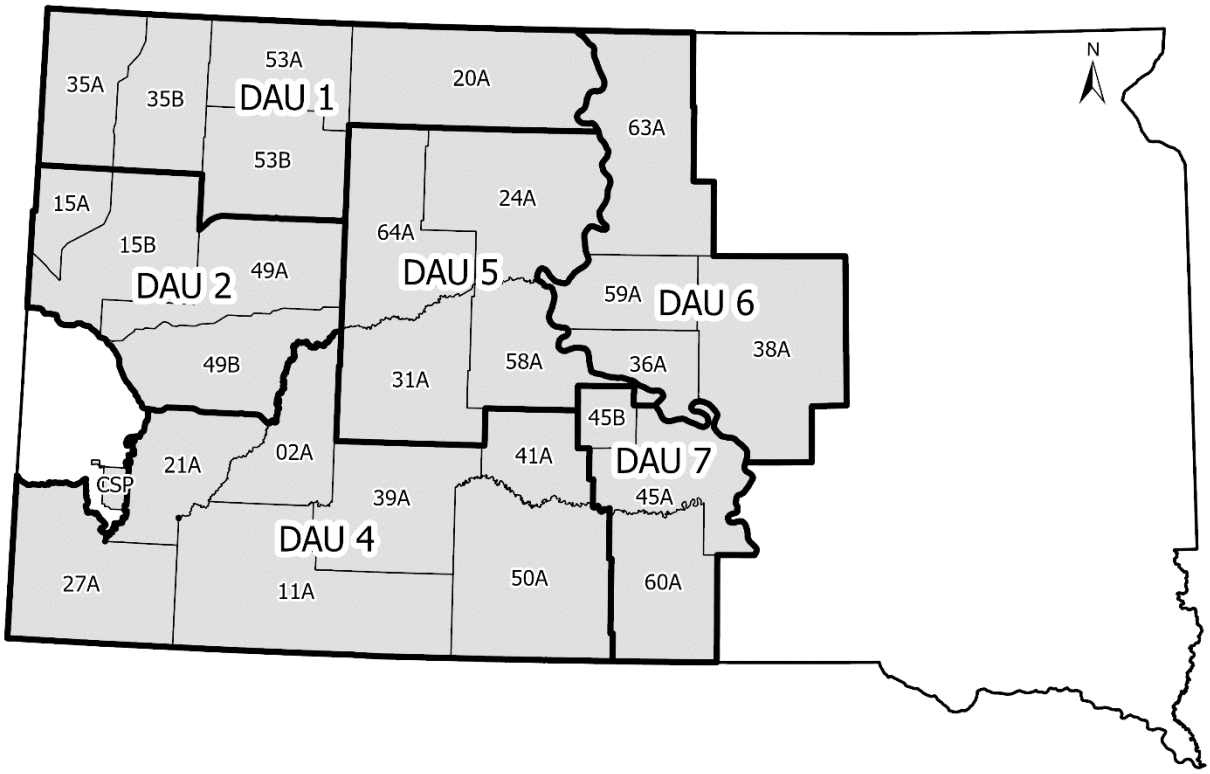

Figure 1. Pronghorn management units (thin black lines) spanning western South Dakota. Pronghorn data analysis units are indicated with thick black lines.

APPENDIX 1

Aerial survey results and population estimates with 95% confidence intervals (LCL and UCL) by hunting management unit, 2013-2022.

Year	Unit	Count	Population	LCL	UCL
2013	02A	356	1,068	803	1,333
2013	11A	397	1,207	786	1,627
2013	15A	246	738	507	969
2013	15B	750	2,250	1,826	2,674
2013	20A	260	780	611	949
2013	21A	519	1,557	1,244	1,870
2013	24A	171	749	578	921
2013	27A	862	2,586	2,289	2,883
2013	31A	290	870	691	1,049
2013	35A	654	1,962	1,567	2,357
2013	35B	475	1,425	1,087	1,763
2013	36A	198	198	198	198
2013	39A	280	840	633	1,047
2013	41A	125	375	242	508
2013	45A	24	72	15	129
2013	45B	28	84	20	148
2013	49A	834	2,502	2,146	2,858
2013	49B	370	1,110	874	1,346
2013	50A	145	435	308	562
2013	53A	237	711	576	846
2013	53B	500	1,500	1,257	1,744
2013	58A	200	600	474	726
2013	59A	129	129	129	129
2013	60A	42	126	38	214
2013	63A	105	105	105	105
2013	64A	463	1,389	1,091	1,687
2013	CU1	174	174	NA	NA
2014	CU1	138	138	NA	NA
2015	02A	177	531	360	702
2015	11A	316	961	595	1,326
2015	15A	292	876	695	1,057
2015	15B	977	2,931	2,445	3,417
2015	20A	214	642	459	825
2015	21A	205	615	410	820
2015	24A	178	797	616	979
2015	27A	711	2,133	1,685	2,581
2015	31A	186	558	343	773
2015	35A	813	2,439	1,956	2,922

Year	Unit	Count	Population	LCL	UCL
2015	35B	494	1,482	1,200	1,764
2015	36A	159	159	159	159
2015	39A	197	591	481	701
2015	41A	67	201	114	288
2015	45A	39	117	37	197
2015	45B	19	57	19	95
2015	49A	897	2,691	2,183	3,199
2015	49B	411	1,233	911	1,555
2015	50A	83	249	133	365
2015	53A	199	597	413	781
2015	53B	741	2,223	1,830	2,616
2015	58A	137	411	281	541
2015	59A	94	94	94	94
2015	60A	14	42	10	74
2015	63A	61	61	61	61
2015	64A	316	948	724	1,172
2015	CU1	138	138	NA	NA
2016	CU1	153	153	NA	NA
2017	02A	192	576	437	715
2017	11A	324	982	706	1,258
2017	15A	546	1,638	1,237	2,039
2017	15B	1412	4,236	3,630	4,842
2017	20A	264	792	598	986
2017	21A	282	846	645	1,047
2017	24A	393	1,191	974	1,408
2017	27A	831	2,493	2,062	2,924
2017	31A	190	570	449	691
2017	35A	1211	3,633	3,244	4,022
2017	35B	727	2,181	1,805	2,557
2017	36A	324	324	324	324
2017	39A	291	873	689	1,057
2017	41A	120	360	230	490
2017	45A	86	258	133	383
2017	45B	46	138	70	206
2017	49A	1117	3,351	2,783	3,919
2017	49B	469	1,407	1,135	1,679
2017	50A	100	300	198	402
2017	53A	346	1,038	800	1,276
2017	53B	960	2,880	2,268	3,492
2017	58A	114	342	222	462
2017	59A	296	296	296	296

Year	Unit	Count	Population	LCL	UCL
2017	60A	10	30	-4	64
2017	63A	180	180	180	180
2017	64A	464	1,392	1,116	1,668
2017	67A	27	81	43	119
2017	CU1	110	110	NA	NA
2018	CU1	81	81	NA	NA
2019	02A	165	495	348	642
2019	11A	365	1,106	811	1,402
2019	14A	15	15	15	15
2019	15A	492	1,476	1,119	1,833
2019	15B	1054	3,162	2,714	3,610
2019	16A	1	1	1	1
2019	20A	435	1,305	1,000	1,610
2019	21A	275	825	634	1,016
2019	24A	524	1,647	1,395	1,899
2019	27A	744	2,232	1,765	2,699
2019	31A	178	534	389	679
2019	33A	20	20	20	20
2019	35A	1597	4,791	3,947	5,635
2019	35B	1040	3,120	2,622	3,618
2019	36A	245	245	245	245
2019	39A	270	810	647	973
2019	41A	142	426	271	581
2019	45A	62	186	111	261
2019	45B	46	138	76	200
2019	49A	958	2,874	2,415	3,333
2019	49B	506	1,518	1,229	1,807
2019	50A	113	339	229	449
2019	53A	386	1,158	945	1,371
2019	53B	873	2,619	2,283	2,955
2019	58A	209	627	459	795
2019	59A	222	222	222	222
2019	60A	19	57	-15	129
2019	63A	192	192	192	192
2019	64A	519	1,557	1,245	1,869
2019	67A	21	63	15	111
2019	CU1	86	86	NA	NA
2022	02A	118	354	231	477
2022	11A	252	756	556	956
2022	15A	240	720	514	926
2022	15B	824	2,472	2,115	2,829

Year	Unit	Count	Population	LCL	UCL
2022	20A	474	1,422	1,152	1,692
2022	21A	238	714	509	919
2022	24A	492	1,476	1,202	1,750
2022	27A	788	2,364	1,831	2,897
2022	31A	245	735	500	970
2022	35A	1,126	3,378	2,825	3,931
2022	35B	936	2,808	2,302	3,314
2022	36A	58	58	58	58
2022	38A	31	31	31	31
2022	39A	274	822	644	1,000
2022	41A	121	363	283	444
2022	45A	20	60	40	80
2022	45B	42	126	92	161
2022	49A	678	2,034	1,755	2,313
2022	49B	320	960	770	1,150
2022	50A	169	507	405	609
2022	53A	409	1,227	991	1,463
2022	53B	846	2,538	2,228	2,848
2022	58A	149	447	336	558
2022	59A	103	103	103	103
2022	60A	20	60	37	83
2022	63A	58	58	58	58
2022	CU1	90	90	NA	NA

PRONGHORN POPULATION PROJECTION MODEL

INTRODUCTION

Fall pronghorn (*Antilocapra americana*) population objectives are established at management units (Figure 1). Population projection models are used to annually estimate abundance when aerial observation survey estimates are not available, and project future pronghorn populations and growth rates (λ) at individual management units in South Dakota. Population projection models are only used in a subset of units with large enough populations and consistent unit boundaries that provide robust inference. Units with coefficients of variation (CV) from aerial survey estimates typically below management thresholds (<12.8% CV) recommended for game species (Robson and Regier 1964, Skalski and Millspaugh 2002) are considered adequate for projection models. This usually occurs in units with spring adult population estimates >400. Changes in hunting license allocation and season structure across hunting units are biennially recommended that align population objectives and growth rates (λ) with estimated abundance from projection models. Projection models rely on data collected from biennial aerial observation surveys, annual herd composition and harvest surveys, and intermittent survival monitoring research projects (GFP 2019).

METHODS

The two age-class sex-specific projection model has two stages within each year, the first represents new pronghorn added to the fall population when fawns are born and survive to the beginning of the hunting season, and the second stage removes pronghorn that die through the year starting at the beginning of the hunting season. Pronghorn deaths are related to multiple causes, the majority include harvest, wounding loss, predation, vehicle accidents, starvation, and disease. The population projection is repeated across multiple years to evaluate changes in abundance as a function of potential hunting season changes (Figure 1).

The model is initiated with an estimate of fall adult pronghorn in each hunting unit by multiplying the spring aerial survey population estimate by adult survival from May to the beginning of the hunting season. Adult (>1 year old) male and female cohorts are estimated by multiplying the fall population by 3-year data analysis unit (DAU) averages from herd composition surveys. As an example, adult males are estimated by multiplying the fall adult population by the proportion of adult males observed among all adult pronghorn from fall herd composition counts.

Once the model has been initiated the first year with the number of adult males and adult females in the fall, the 1st of 2 stages that are repeated annually proceeds. New fawns are recruited into the fall population by multiplying fall adult females by the proportion of fawns observed among fawns and females from herd composition surveys. This completes the first stage of the projection model, accounting for fall fawn recruitment (Figure 1).

The 2nd stage removes all deaths that are expected to occur annually starting at the beginning of the hunting season. Average annual non-harvest mortality estimates for adult males, adult females and fawns (~3 to 14 months old), based on known fate data from radiocollared pronghorn in South Dakota, are used to remove deaths not related to harvest. Projections between previous year aerial surveys adjust average annual non-harvest survival using a regression equation as a function of a winter severity index (Baccante and Woods 2010). Total harvest related mortality is removed by subtracting cohort-specific estimates. Because changes to hunting licenses are used to increase or decrease annual mortality rates of adult males, adult females and fawns, the model adjusts estimated harvest based on increases or decreases to adult male (primarily type 41 any antelope) and female/fawn (primarily type 43 doe/fawn) licenses when projecting the population to future years. Assuming additive harvest mortality, changes in license type allocations from the previous year are multiplied by 2-year average license type success rates to predict future harvest. If the license type was not used in the unit in the past 2 years, the 6-year average is used, and if unavailable, the unit is scaled up to the DAU, or entire state, until an average can be estimated. Fawns remaining at the end of the year are aged into the adult cohort, assuming a 50:50 sex ratio. This completes the annual cycle resulting in a pre-recruitment population. The process is repeated for subsequent years as illustrated in figure 1. Population parameters were optimized by comparing projections between spring aerial survey estimates in 2013, 2015, 2017, 2019 and 2022. Monte Carlo simulation methods are used to estimate variation and produce confidence intervals on population estimates.

RESULTS

Data from aerial surveys in 2022 resulted in an estimate of 28,264 pronghorn in the spring and 90 pronghorn in Custer State Park from ground survey counts. A 3-year DAU average from 2019-2021 fall herd composition data was used to estimate adult males and adult females at each hunting unit after multiplying the 2022 aerial survey estimate by adult survival from May to the beginning of the hunting season (93%). Fawns were recruited into the fall population by multiplying the adult females by the 2019-2021 DAU average fawn:100 adult female ratio. Annual fawn non-hunting mortality (24%), adult female non-hunting mortality (17%), and adult male non-hunting mortality (17%) was used to project each population cohort to the next year.

An 18% decrease was estimated between the 2019 and 2022 pre-hunt population. Based on recommended hunting season licenses, from 2022 to 2024, an 11% population increase was projected. Model projections are based on average conditions and subject to error associated with bias or sampling and process variance of input parameters. Historic projections by DAU are illustrated in figures 2 through 6.

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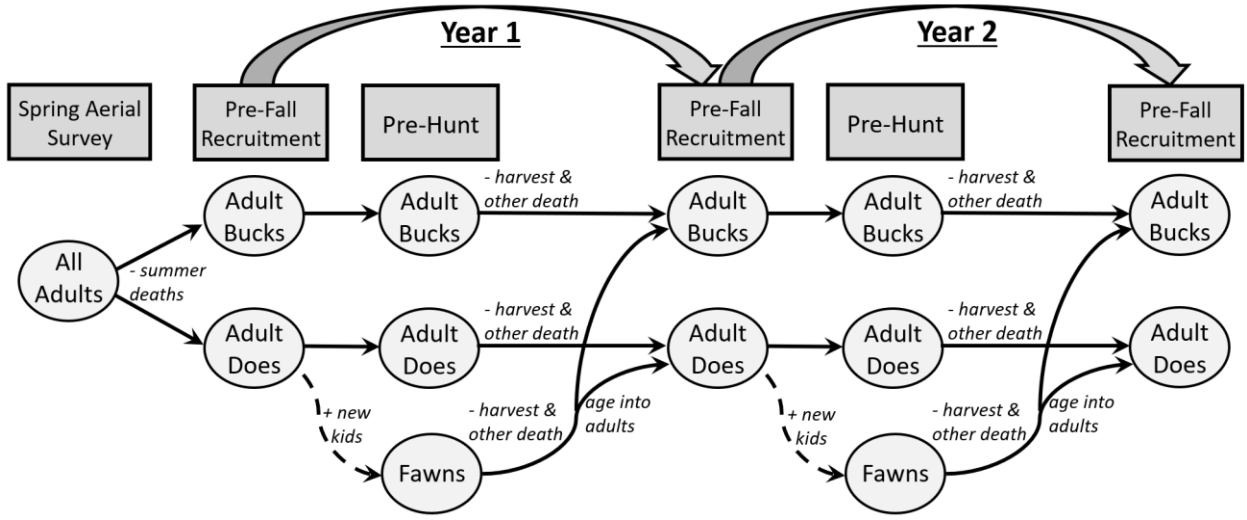

Figure 1. Graphical illustration of the pronghorn population projection model used to predict population growth rates as a function of varying hunting season recommendations.

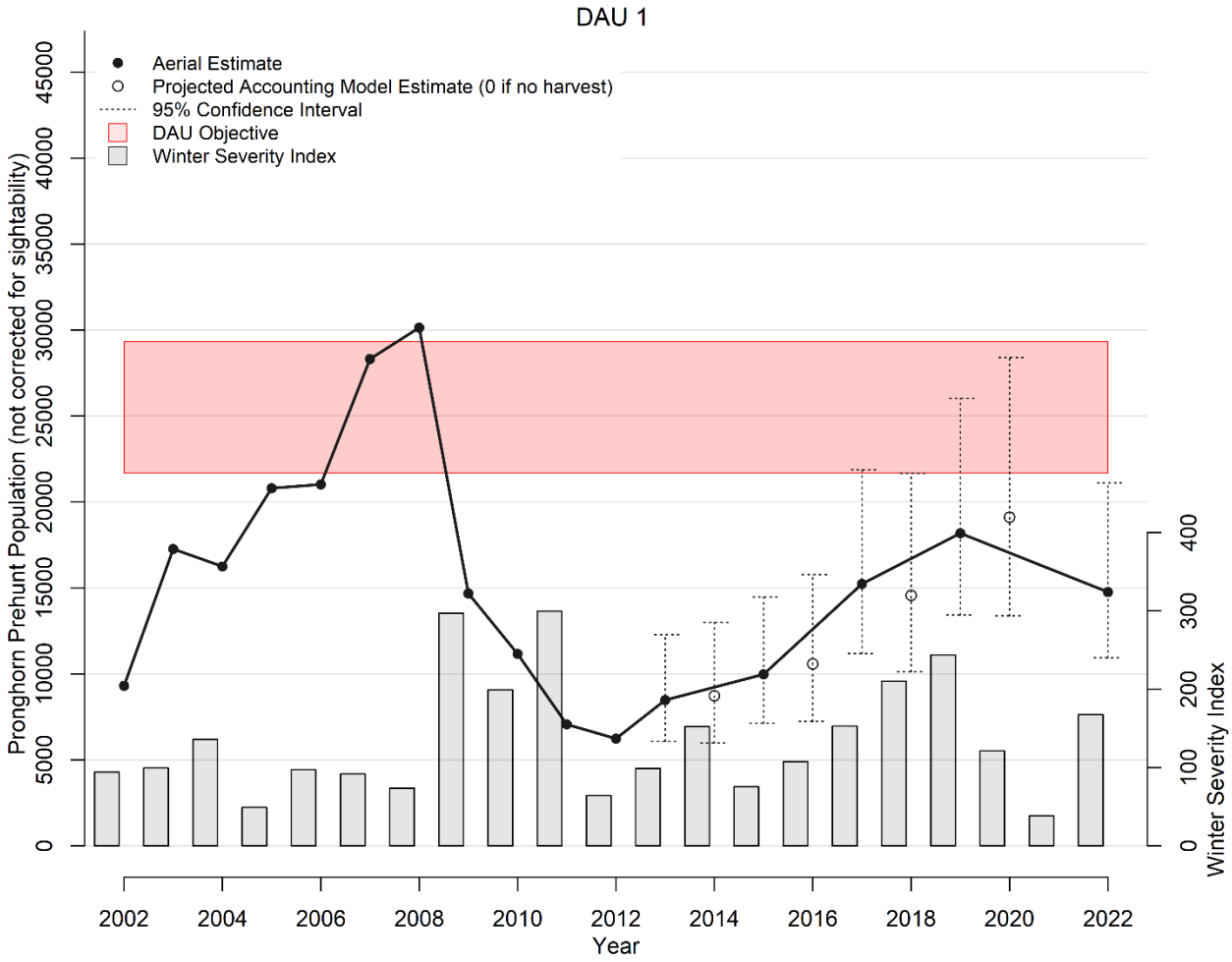

Figure 2. Population projections (open circles) from historic spring aerial survey estimates projected to fall (black circles) in data analysis unit (DAU) 1 (northwest SD). Ninety-five percent confidence intervals are displayed by dotted lines. Abundance estimates are scaled to aerial survey counts (i.e., multiplied by 86%) to provide accurate "count" projections to evaluate relative to population objectives which are based on counts not corrected for sightability.

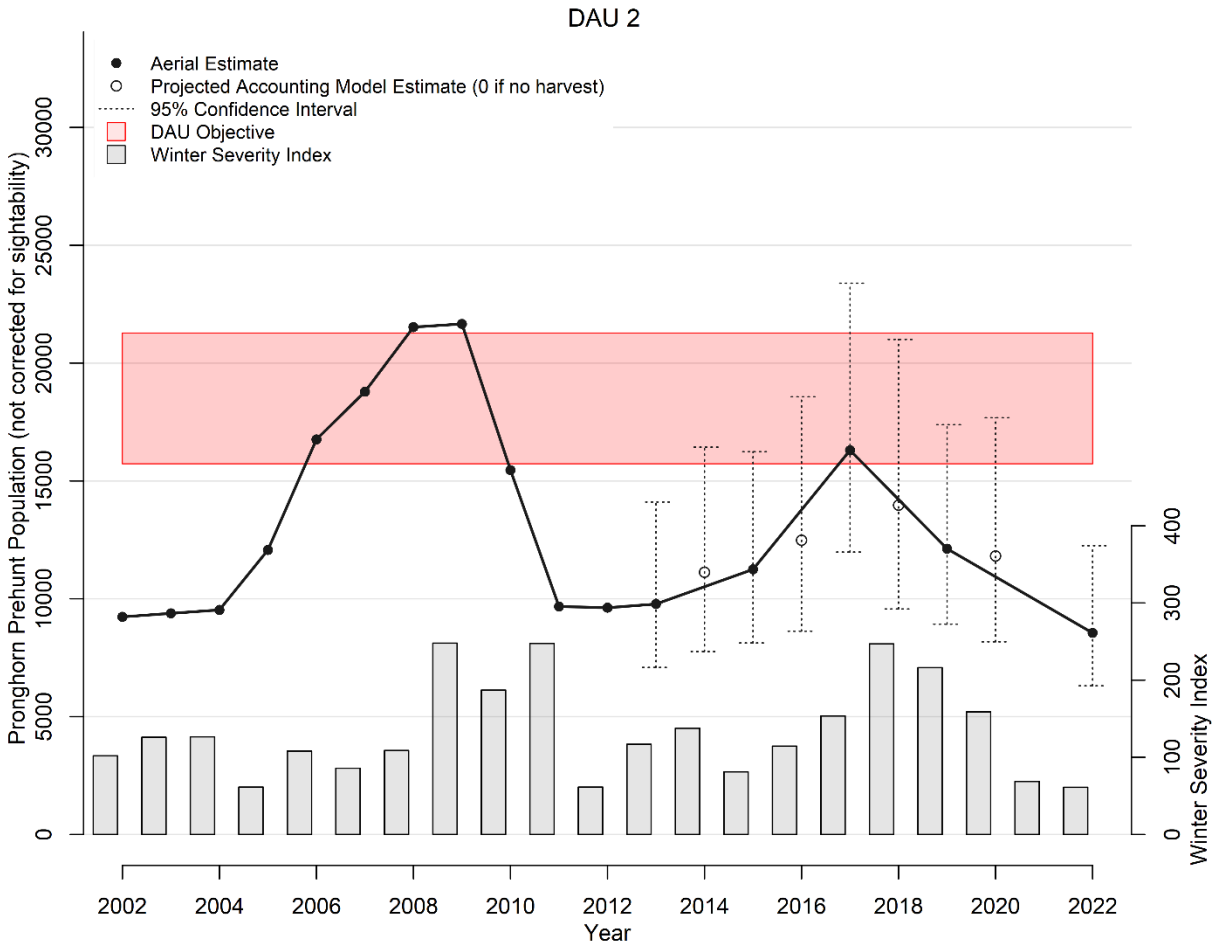

Figure 3. Population projections (open circles) from historic spring aerial survey estimates projected to fall (black circles) in data analysis unit (DAU) 2 (west central SD). Ninety-five percent confidence intervals are displayed by dotted lines. Abundance estimates are scaled to aerial survey counts (i.e., multiplied by 86%) to provide accurate "count" projections to evaluate relative to population objectives which are based on counts not corrected for sightability.

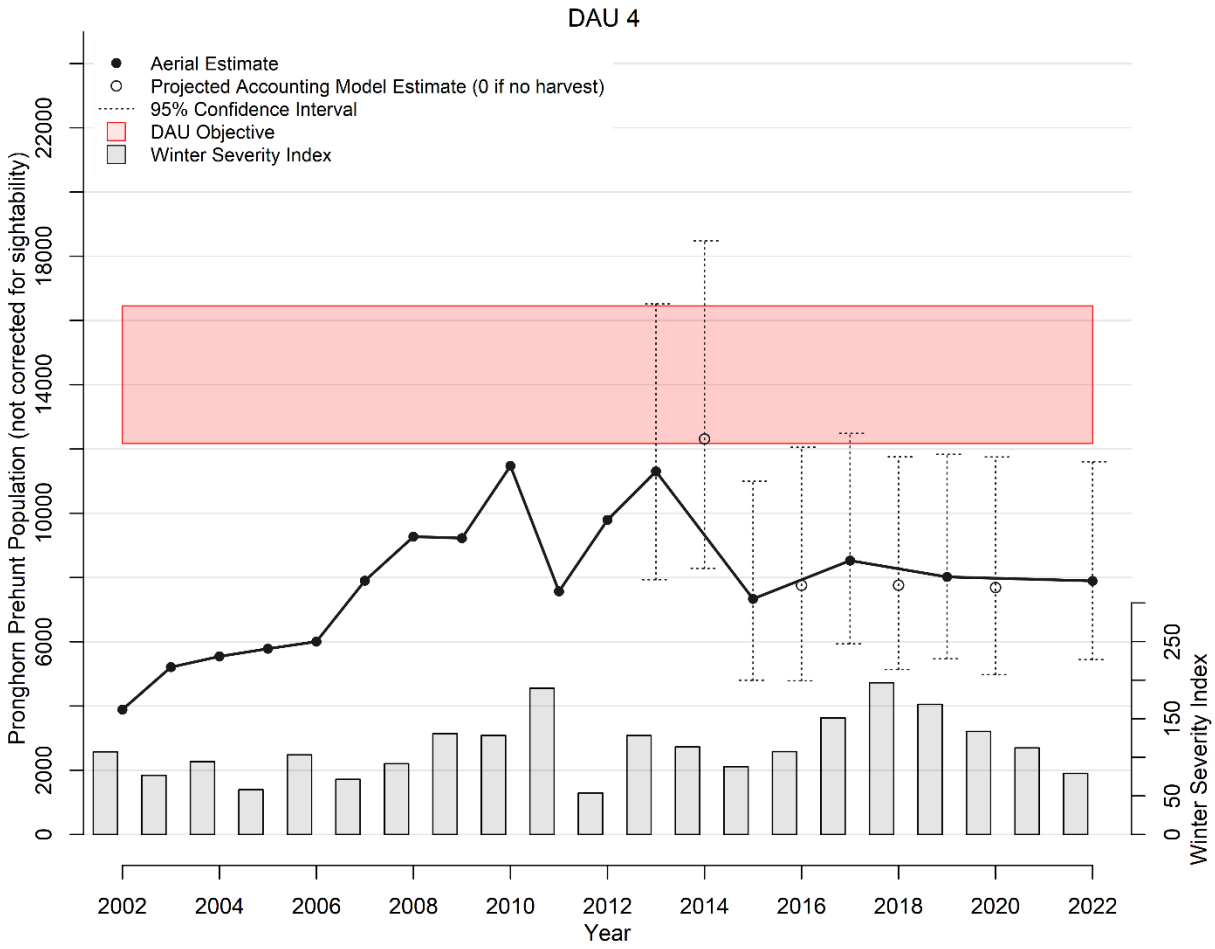

Figure 4. Population projections (open circles) from historic spring aerial survey estimates projected to fall (black circles) in data analysis unit (DAU) 4 (southwest SD). Ninety-five percent confidence intervals are displayed by dotted lines. Abundance estimates are scaled to aerial survey counts (i.e., multiplied by 86%) to provide accurate "count" projections to evaluate relative to population objectives which are based on counts not corrected for sightability.

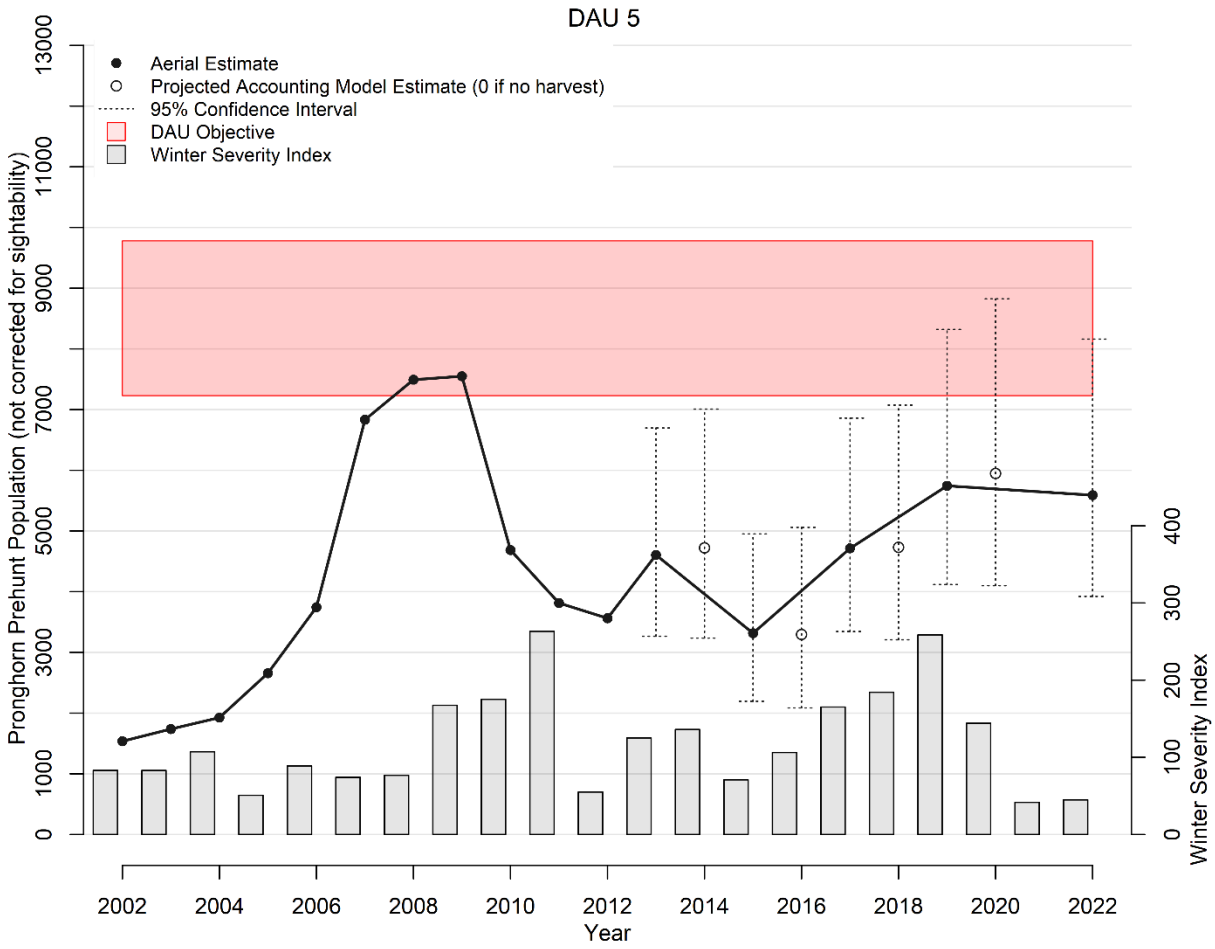

Figure 5. Population projections (open circles) from historic spring aerial survey estimates projected to fall (black circles) in data analysis unit (DAU) 5 (central SD). Ninety-five percent confidence intervals are displayed by dotted lines. Abundance estimates are scaled to aerial survey counts (i.e., multiplied by 86%) to provide accurate "count" projections to evaluate relative to population objectives which are based on counts not corrected for sightability.

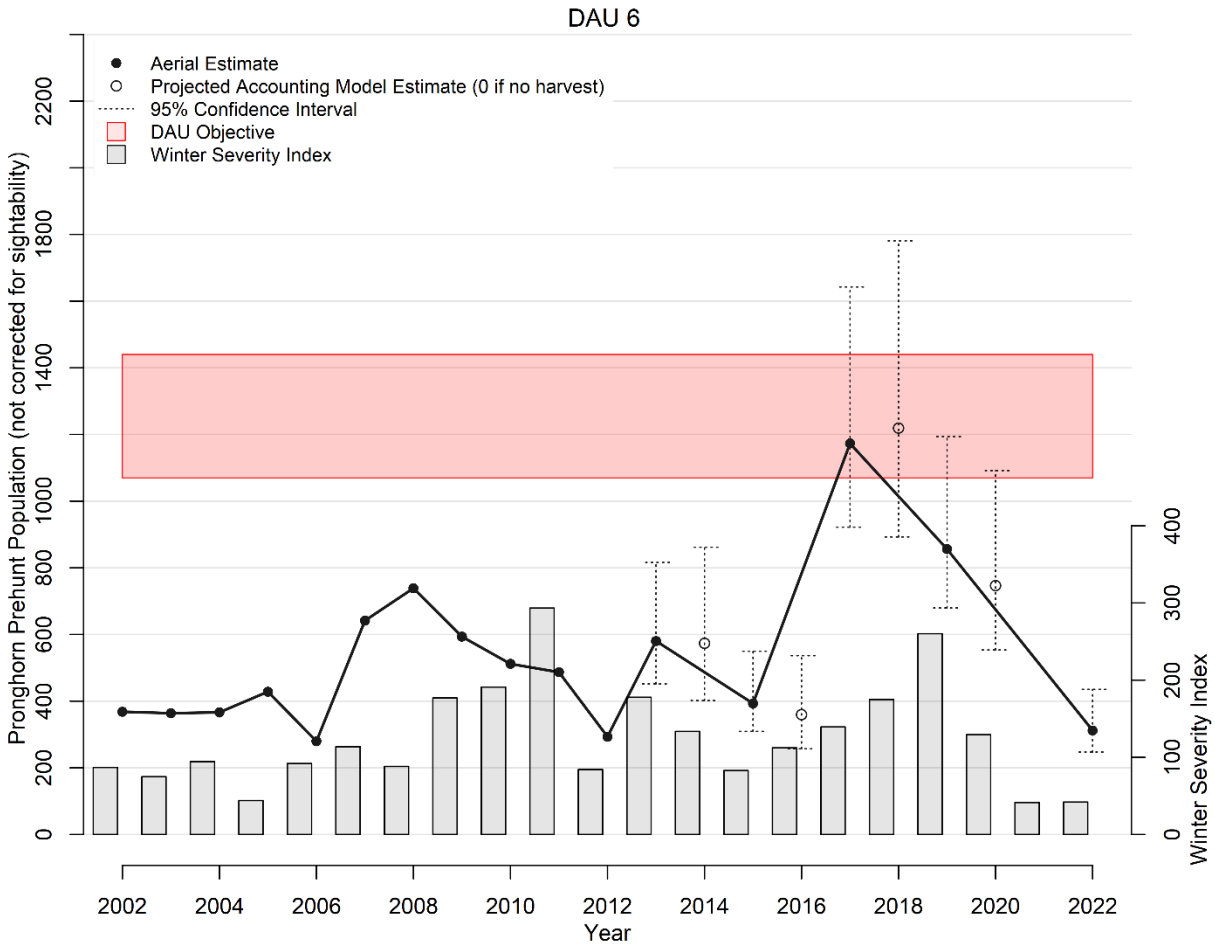

Figure 6. Population projections (open circles) from historic spring aerial survey estimates projected to fall (black circles) in data analysis unit (DAU) 6 (East River SD). Ninety-five percent confidence intervals are displayed by dotted lines. Abundance estimates are scaled to aerial survey counts (i.e., multiplied by 86%) to provide accurate "count" projections to evaluate relative to population objectives which are based on counts not corrected for sightability.